NASA Innovative Advanced Concepts

Contour Crafting Simulation Plan for Lunar Settlement Infrastructure Build-Up

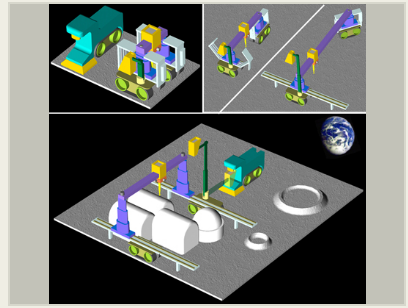
Completed Technology Project (2011 - 2012)

Project Introduction

Economically viable and reliable building systems and tool sets are being sought, examined, and tested for extraterrestrial habitat and infrastructure buildup. This proposal uses a unique architecture weaving an automated building technology called Contour Crafting (CC) with designs for assisting rapid buildup of an initial operational capability lunar base. Using CC technology, this proposal intends to draw up a detailed plan for a high-fidelity simulation at NASA's Desert Research and Technology Studies (D-RATS) facility, to construct certain crucial infrastructure elements in order to evaluate the merits, limitations, and feasibility of adapting and using the CC technology for extraterrestrial application. Elements suggested to be built and tested include roads, landing pads and aprons, shade walls, dust barriers, thermal and mm protection shields and dust-free platforms as well as other built-up structures utilizing the well known in-situ resource utilization (ISRU) strategy. Several unique systems including the Lunar Electric Rover, the unpressurized Chariot rover, the versatile light-weight crane, and Tri-Athlete cargo transporter as well as the habitat module mockups and a new generation of spacesuits are undergoing coordinated tests at NASA's D-RATS. This proposal intends to draw up a detailed synergetic plan to utilize these maturing systems coupled with the CC fabrication technology, tailored for swift and reliable lunar infrastructure development. This proposal intends to increase astronaut safety, improve buildup performance, ameliorate lunar dust interference and concerns, and attempts to reduce time-to-commission, all in an economic manner. As part of this proposal, a figure-of-merit methodology will be created and employed to gain some quantitative insight into the efficiency of using the CC technology to augment these other systems already in place.

Anticipated Benefits

This project hopes to enable economically viable and reliable building systems and tool sets for extraterrestrial infrastructure buildup.



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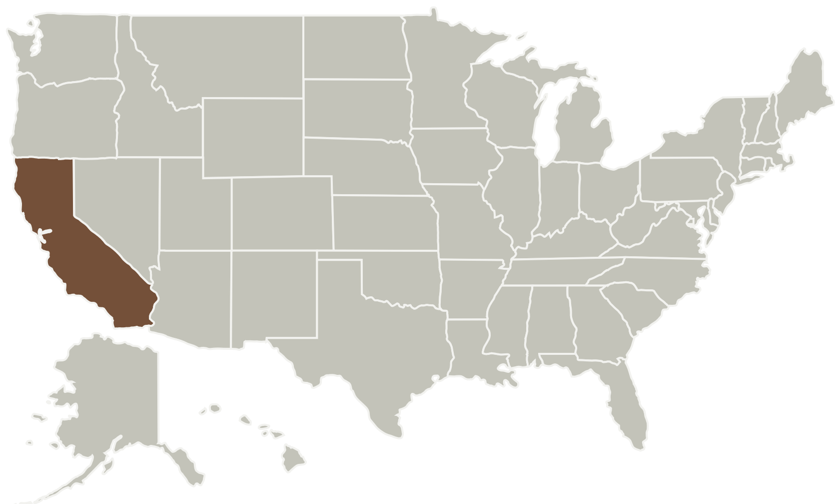
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
University of Southern California(USC)	Lead Organization	Academia	Los Angeles, California
University of Illinois at Urbana-Champaign	Supporting Organization	Academia	Urbana, Illinois

Primary U.S. Work Locations
California

Project Transitions

September 2011: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

University of Southern California (USC)

Responsible Program:

NASA Innovative Advanced Concepts

Project Management

Program Director:

Jason E Derleth

Program Manager:

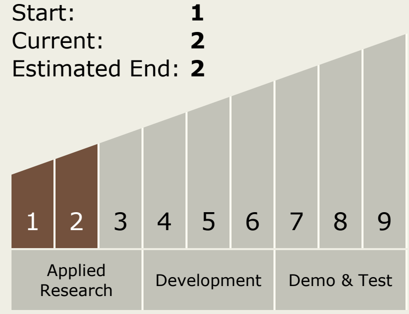
Eric A Eberly

Principal Investigator:

Behrokh Khoshnevis

Technology Maturity (TRL)

Start: **1**
Current: **2**
Estimated End: **2**



September 2012: Closed out

Closeout Summary: We feel fortunate to have received the NIAC Phase-II gra nt which has given us the opportunity to continue to work on this exciting and re warding project. We have numerous new ideas that we would like to attempt an d implement in the course of our current NIAC project. In addition to research t hat will advance the maturity of the proposed architecture, we anticipate other d ivisions of NASA to be interested in expanding the robotic construction methods that we will develop to build other types of ISRU basedmcomponents beyond ba sic infrastructure. Robotic construction technologies could build tools, other robo ts, scientific equipment and many other objects that can be formed from excava ted and processedmextraterrestrial materials. We also anticipate major contribut ions by robotics and co-robotics researchersmat NASA divisions to integrate our proven fabrication technologies with space-worthy advanced class of NASA robot ics hardware and intelligent software. Once such integration materializes excitin gdemonstrations at D-RATS will be performed and following successful demonstr ation and refinement the ultimate dream of actual Lunar settlement construction will be realized. A robotic construction system can also provide tremendous ben efits for human habitation on Earth. Construction is the last frontier of human en deavor to be automated. Automated building technologies will revolutionize the way structures are built on Earth, in dense urban environments, in difficult-to-b uildand difficult-to-service sites, or in remote and hostile regions of the globe. T he technologies under development by our group have the potential to simplify c onstruction logistics, reduce the need for hard physical labor by assigning huma ns to a strictly supervisory role, eliminate issues relating to human safety, and p roduce intricate and aesthetically refined designs and structures at significantly r educed construction cost. Space architecture in general and Lunar and Martian s tructures in particular will also provide a rich new aesthetic vocabulary for archit ects to employ in the design and creation of buildings that employ high technolo gy and building information modeling that is vital for optimizing use of materials and energy that is critical to building economics. We anticipate this NIAC initiate d endeavor to ultimately lead to revolutionizing construction on our planet and s ignificantly impacting the quality of life for billions of people and improving the s tate of the earth environment. The recently published Roadmap for US Robotics has identified several key areas and related enabling technologies for co-robotic s which will result in US economic expansion. Robotic construction falls into two categories of manufacturing and professional services identified in that Roadma p. The economics of the proposed approach will enable the construction of durab le, low-cost housing in the US and worldwide, and can enable much faster disast er recovery. Replacing human workers with robots on construction sites will red uce the injuries and fatalities of construction, which has long been recognized as the most hazardous occupation. Some of the specific proposed research module s will also have broad impacts. For example, construction using sand and withou t the use of water would be extremely useful for dry climates, and the work on r adiation shielding may lead to terrestrial benefits such as improved and more ec onomical shielding at nuclear power plants and nuclear waste storage sites. Stu dent involvement will develop uniquely experienced future US construction robot ic engineers and researchers.

Technology Areas

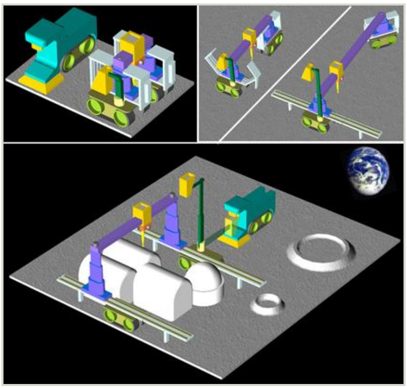
Primary:

- TX07 Exploration Destination Systems
  - └ TX07.2 Mission Infrastructure, Sustainability, and Supportability
    - └ TX07.2.3 Surface Construction and Assembly

Target Destination

The Moon

Images



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Project Image Contour Crafting Simulation Plan for Lunar Settlement Infrastructure Build-Up *(https://techport.nasa.gov/image/102085)*